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THE WEATHER AND CIRCULATION OF DECEMBER 1969

Record December Snowfall in the Northern and Central Appalachian Mountains

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1. MEAN CIRCULATION

Increasing cyclonic activity in the Pacific during December developed a deep elongated mean 700-mb low-pressure area from the Gulf of Alaska across the Kamchatka Peninsula into eastern Asia (fig. 1). At the same time, 700-mb heights rose in the subtropical portions of the North Pacific (fig. 2). The resulting 700-mb wind speeds were 8 to 10 m sec^{-1} above normal along the axis of the strongest winds over the Pacific (fig. 3). These strong winds forced a progression of the downstream wave train. A trough that was located over the eastern United States during November (Green 1970) moved to the coast with a mean upper level Low forming over Quebec. Concomitantly the extremely strong Atlantic ridge advanced about 10° eastward, and the lower latitude part of the eastern Atlantic trough moved into the Mediterranean.

The positive height anomaly center associated with the Atlantic ridge, although 20 m less than the November value, was still 150 m above normal (fig. 4). Downstream and upstream from this strong ridge, split westerly patterns developed this month. South of the northern branch of westerlies over Canada, the monthly increase in height anomaly was equal in magnitude to the positive anomaly created, both being 110 m (figs. 2 and 4). South of the northern westerly branch over Scandinavia, 700-mb heights averaged 230 m higher in December than during November, forming a positive anomaly center of 150 m in the ridge over northern Asia. The anomalously strong northwesterly flow over Asia, east of this blocking ridge, contributed to the deepening of the complex Pacific Low this month.

2. MONTHLY TEMPERATURE

The temperature regime of November persisted through December (fig. 5). Most of the western half of the Nation was warmer than normal, while the East was colder than normal. The exception to the eastern coldness was northern New England, where easterly anomalous flow kept temperatures above normal. Elsewhere in the East, below-normal 700-mb heights and generally northerly anomalous flow aloft accounted for the low temperatures in much the same manner as in November. The warmth of the West was brought about somewhat differently than during November when a warm dry regime resulted from widespread subsidence. The December warmth was more advective in nature, for 700-mb heights in the western ridge were near normal. A major factor in this month's warmth was the strong positive height anomaly over Canada with the anomalous easterly flow across southern Canada that prevented the usual periodic intrusions of colder air from Polar latitudes.

3. MONTHLY PRECIPITATION

The advancing long-wave trough in the East caused widespread heavy precipitation from the Southern Plains northeastward through New England (fig. 6). The northern part of this precipitation was mainly in the form of snow. Record monthly snowfall amounts were recorded in the Appalachian Mountains from West Virginia to Vermont. In some instances, the December total snowfall this year far exceeded the previous records for this month. Albany, N.Y., reported a monthly total of 57.5 in., which compares with the previous record of 40.3 in. Several stations nearer the coast, including Boston, Mass., Hartford, Conn., Trenton, N.J., and Portland, Maine, reported record total precipitation for December instead of record snowfalls.

The northeasterly anomalous flow (fig. 4) over Minnesota and adjacent States also brought unusually heavy snowfall to that region. At St. Cloud, Minn., monthly totals were only one-half inch short of a record, but the precipitation total of 2.04 in. did establish a new December record.

The heavy precipitation in the Northwest was associated with the increased storm activity across the Pacific. Frequent occluded fronts moved into the western mountains, but only one low-pressure center moved through the Northwest during December.

4. INTRAMONTHLY VARIATIONS

Positive 700-mb height anomaly and easterly anomalous flow in the middle troposphere (figs. 7A and B) were related to above-normal temperatures over the Northern Plains and the Northern Mississippi Valley the first week of December (fig. 7C), but in the Northwest the same upper level condition was associated with below-normal temperatures. The apparent inconsistency in the Northwest is explainable by consulting the sea-level pressure pattern (not shown). A fairly strong surface High persisted over the Northwest much of the week, and outgoing radiation during the long nights exceeded the incoming radiation during the day, which in the absence of warm air advection resulted in a net cooling and below-normal temperatures.

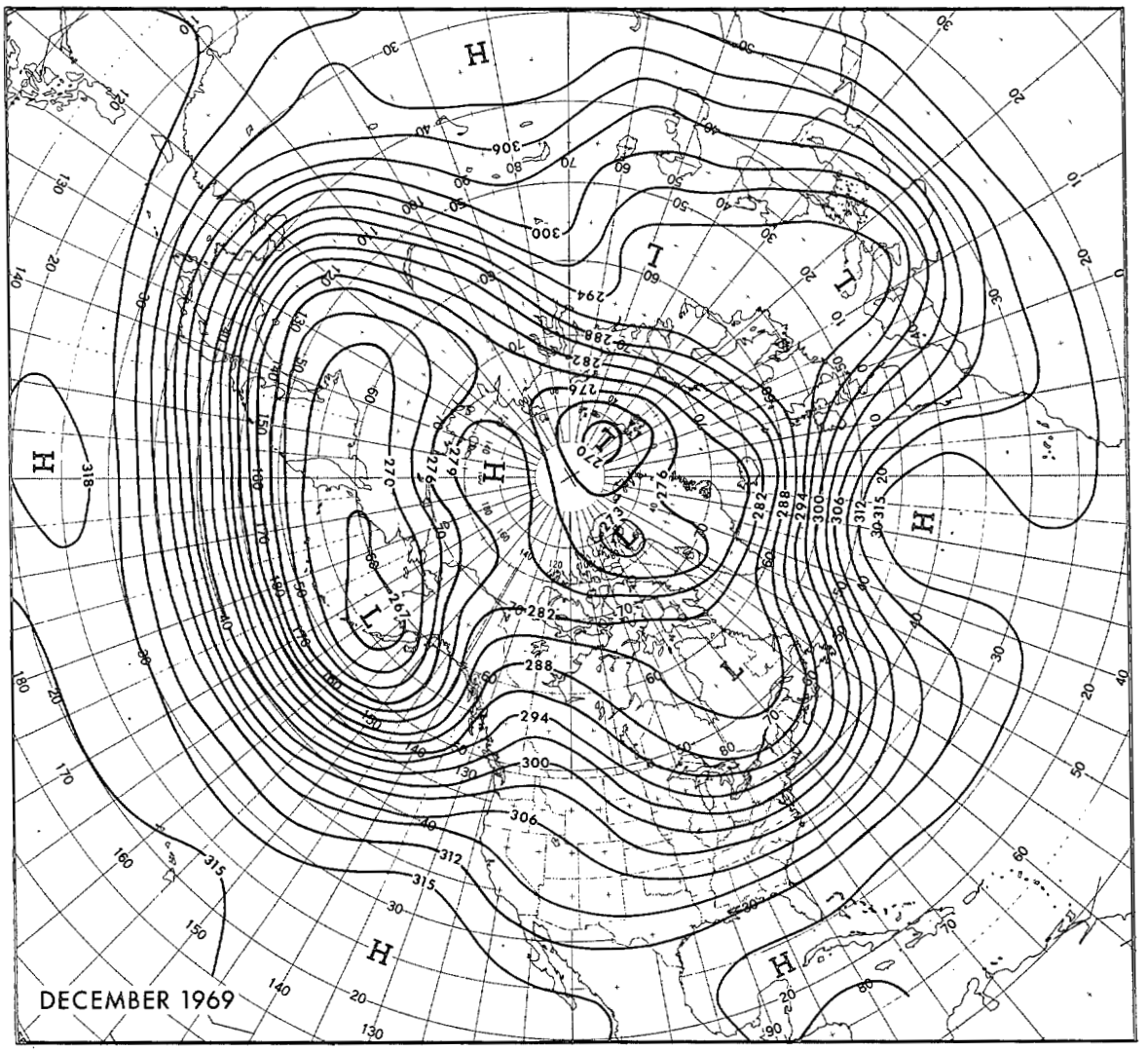


FIGURE 1.—Mean 700-mb contours (in decameters) for December 1969.

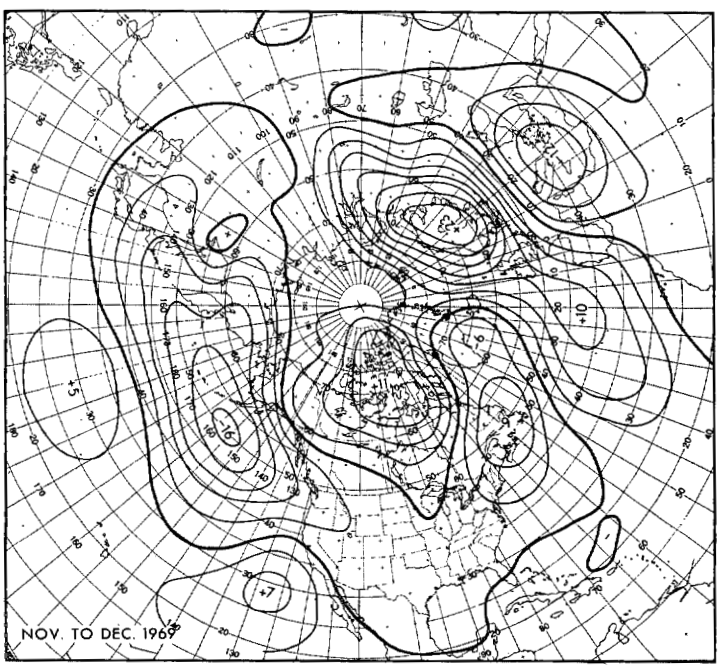


FIGURE 2.—Mean 700-mb height anomaly change (in decameters) from November to December 1969.

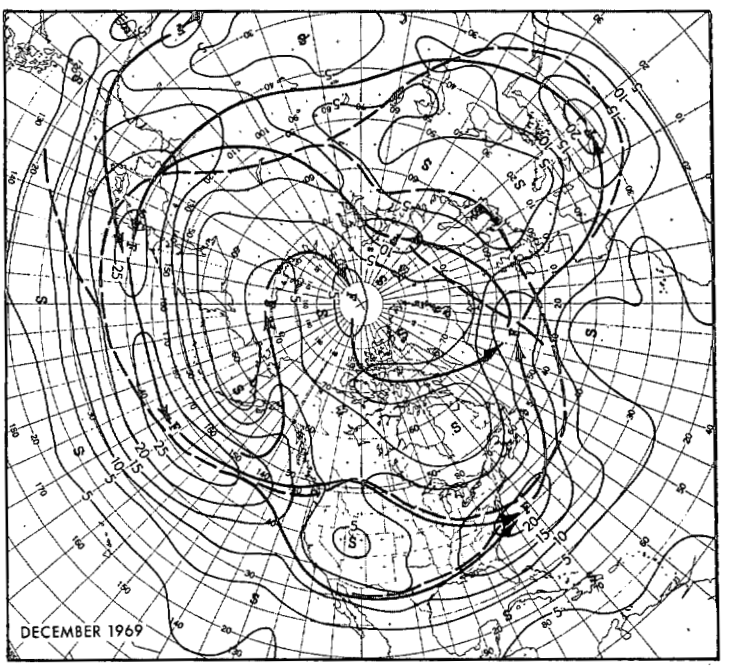


FIGURE 3.—Mean 700-mb wind speeds (m sec^{-1}) for December 1969. Light solid lines are isotachs, heavy solid lines are axes of maximum wind speeds, and dashed lines are normal axes of maximum wind speeds.

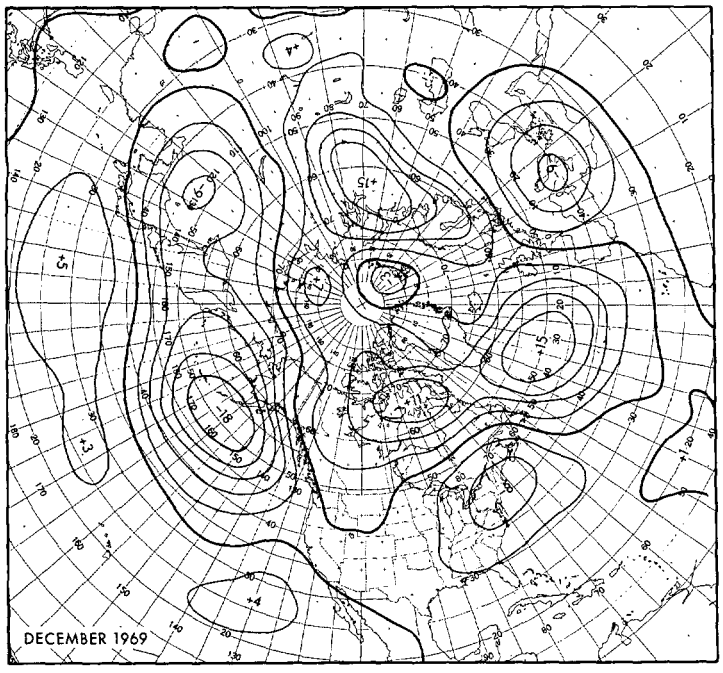


FIGURE 4.—Departure from normal of the mean 700-mb height (in decameters) for December 1969.

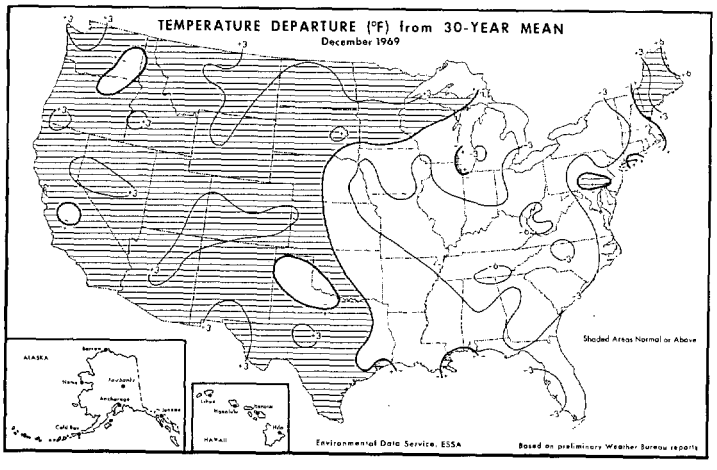


FIGURE 5.—Departure from normal of the average surface temperature (°F) for December 1969 (from Environmental Data Service 1970).

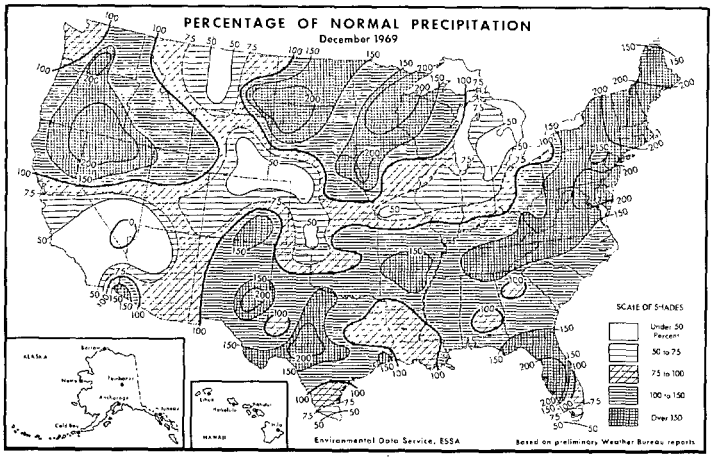
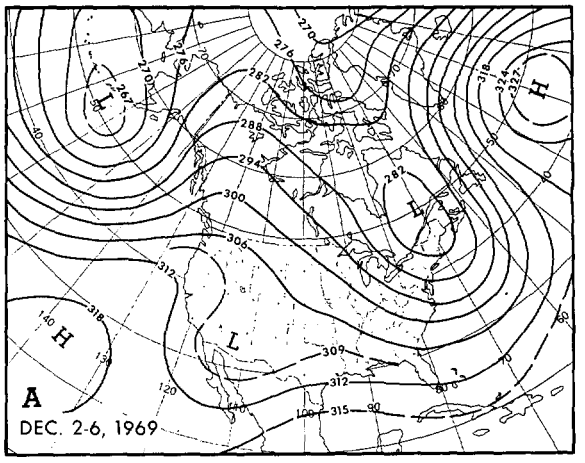
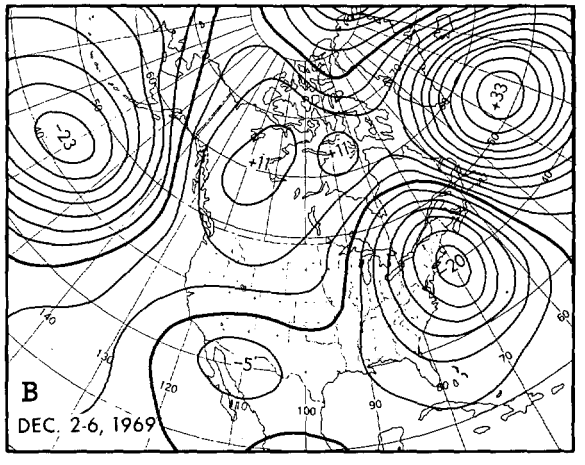
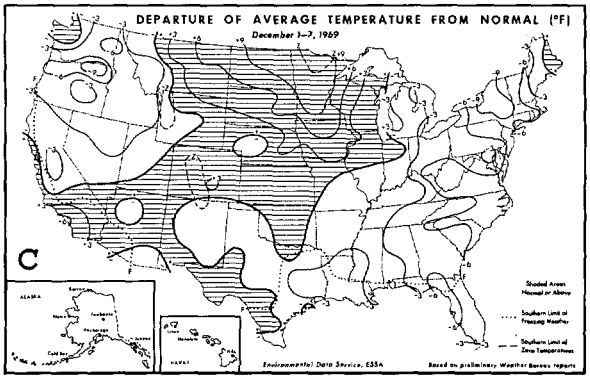


FIGURE 6.—Percentage of normal precipitation for December 1969 (from Environmental Data Service 1970).







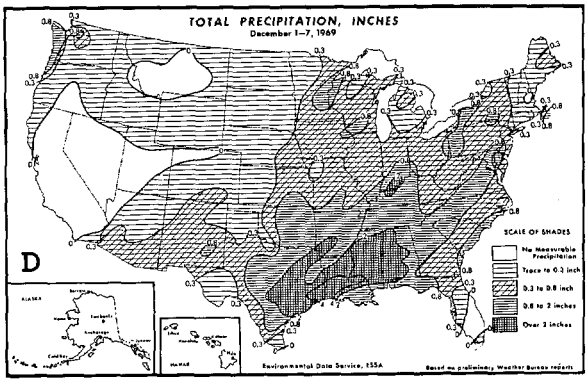


FIGURE 7.—(A) mean 700-mb contours and (B) departure from normal (both in decameters) for Dec. 2-6, 1969; (C) departure of average surface temperature from normal (°F) and (D) total precipitation (inches) for week of Dec. 1-7, 1969 (from Environmental Data Service 1969).

Strong northerly anomalous flow and below-normal 700-mb heights were associated with below-normal temperatures in most of the East and the Gulf Coast States this week.

The only area of very heavy precipitation early in December (fig. 7D) was associated with the region of confluence to the east of the cut-off southwestern Low (fig. 7A). Some areas had heavy snow fall this week. Accumulations up to 7 in. were reported in Kansas, and as much as 9 in. were recorded in northern Missouri. Snowfall up to 12 in. occurred in parts of Ohio, Wisconsin, and Michigan.

Retrogression of the East Coast trough occurred the second week with strong cooling accompanying the falling 700-mb heights in the North Central States, while the increased southerly flow and rising heights brought warming to the Northeast (fig. 8A, B, and C). Persistent below-normal 700-mb heights continued to be associated with below-normal temperatures in the Southeast. Falling 700-mb heights and sharply increased westerlies brought mild Pacific air and rapidly rising temperatures into the Northwest this week. The resulting temperature pattern across the Nation was predominantly above-normal interspersed with patches of below-normal.

Precipitation increased in the Northwest (fig. 8D) as the west and southwest flow increased. An intensifying storm off the west coast in the latter part of the week battered coastal areas with wind gusts of more than 100 mi hr^{-1}. Over 5 in. of rain fell during the afternoon and evening of the 11th at Cape Blanco, Oreg., where winds gusted to about 110 mi hr^{-1}. An unusual West Coast phenomenon, a tornado, was reported near Seattle with the passage of this storm. In the East, an increase of southerly flow spread generally heavy precipitation from Florida to New England. Several tornadoes were reported in Florida on the 10th, as a storm moved through the Southeast.

During the third week of December, differential motion over North America brought in phase a progressing low-latitude wave train with a retrograding high-latitude wave train. The resulting amplification of the western ridge and the eastern trough caused sharply contrasting temperature regimes in eastern and western parts of the country (figs. 9A, B, and C). In the East, only northern New England remained warmer than normal, and this positive temperature anomaly could be attributed to an easterly anomalous flow aloft. A combination of subsidence and advective warming associated with the amplifying western ridge removed the pockets of below-normal temperatures present in the West the previous week, giving mild weather to most sections west of the Mississippi River.

Moderate to heavy precipitation fell along much of the West Coast under the continued southwesterly flow aloft (fig. 9D), but the strong ridge kept most of the central part of the United States relatively dry as it had been the previous week. In fact, strong winds raised clouds of dust in local areas of eastern Colorado where no precipitation had fallen since early December. The ad-

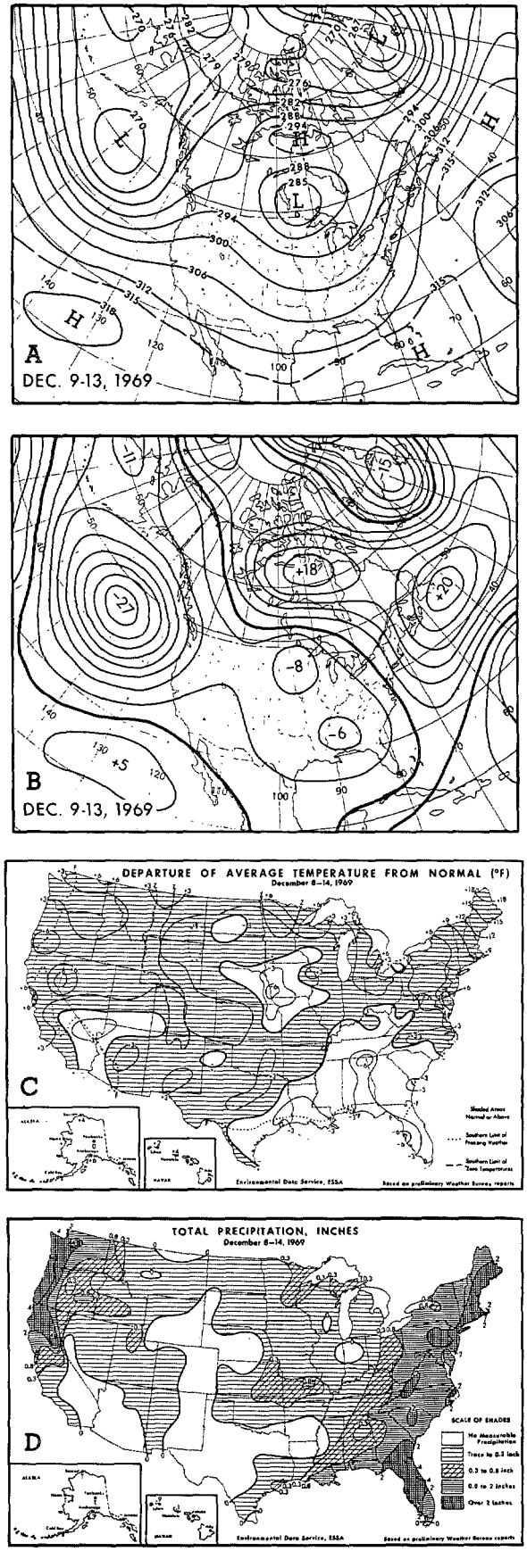
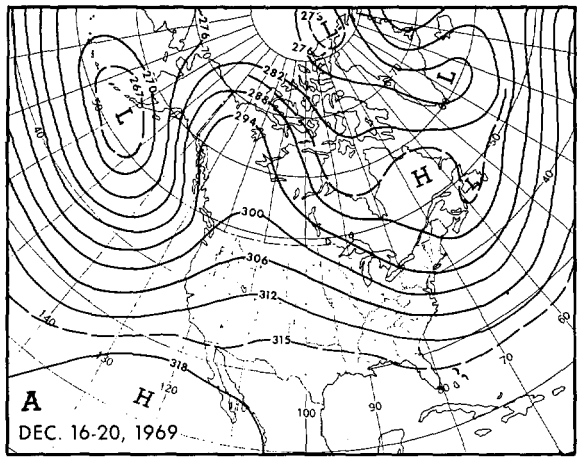
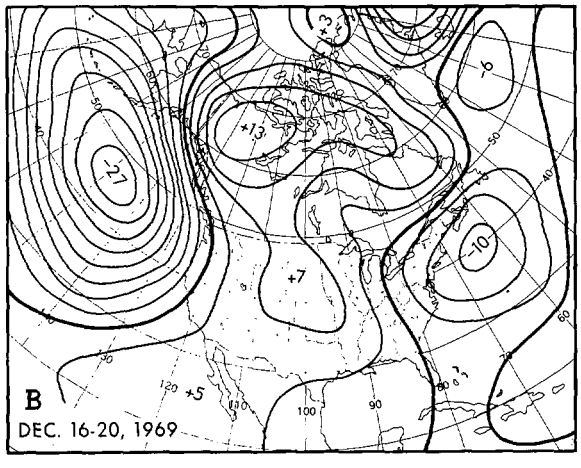
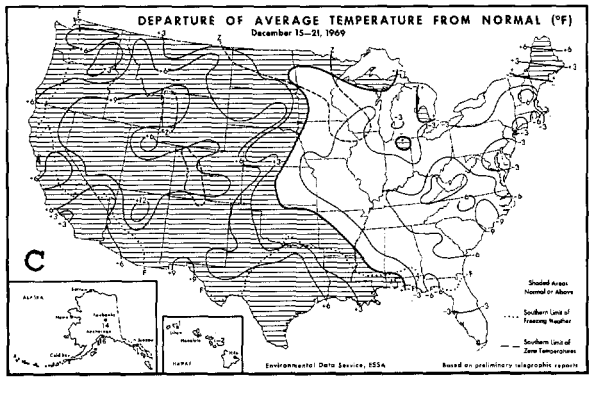


FIGURE 8.—Same as figure 7, (A) and (B) Dec. 9–13, 1969; (C) and (D) for week of Dec. 8–14, 1969 (from Environmental Data Service 1969).







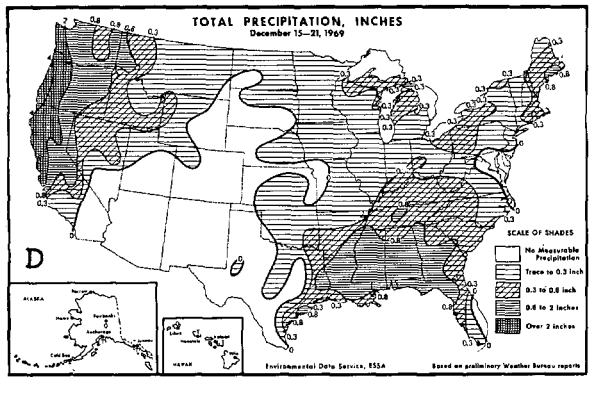
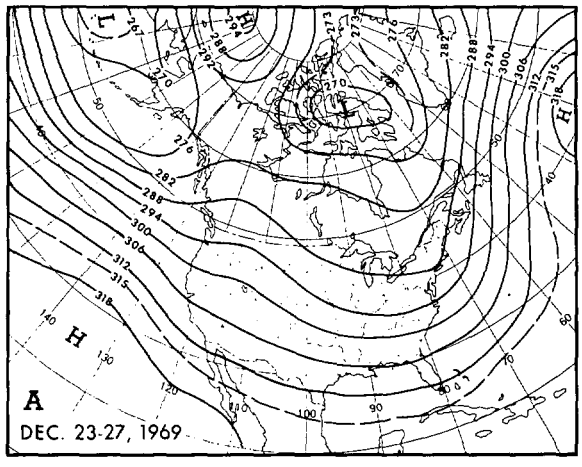
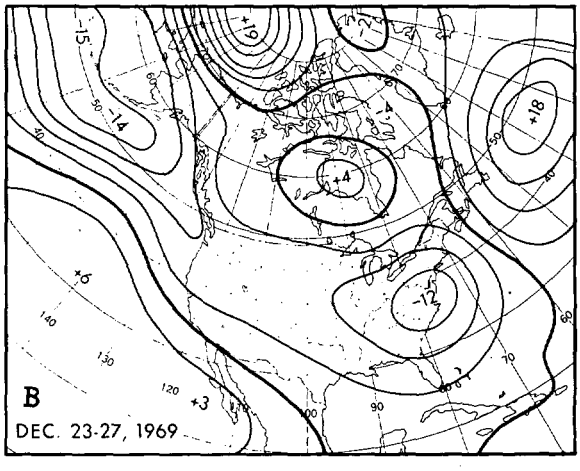
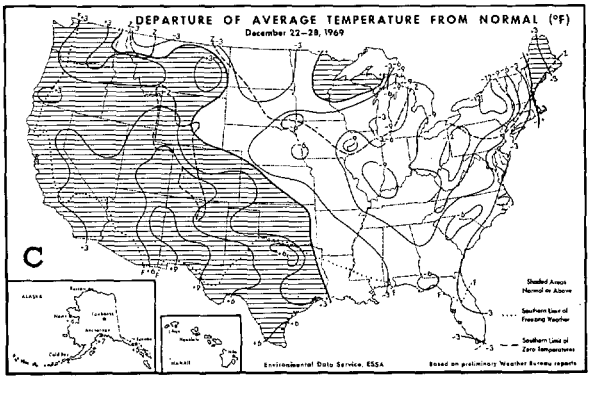


FIGURE 9.—Same as figure 7, (A) and (B) Dec. 16–20, 1969; (C) and (D) for week of Dec. 15–21, 1969 (from Environmental Data Service 1969).







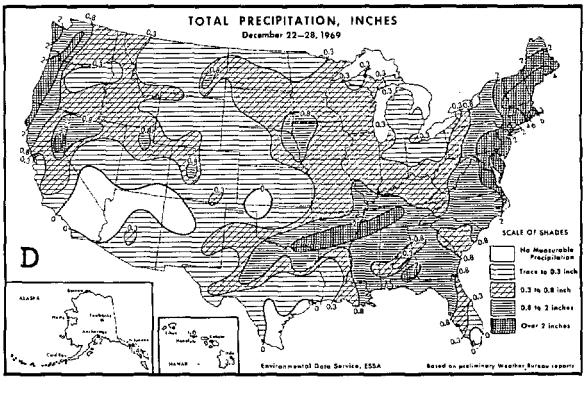


FIGURE 10.—Same as figure 7, (A) and (B) Dec. 22–28, 1969; (C) and (D) for week of Dec. 22–28, 1969 (from Environmental Data Service 1969).

vancing eastern trough was associated with snowfall that began early in the week in the Northeast with some areas having daily occurrences of snow. Totals ranged widely, but some sections of Wisconsin and from Indiana to New England received 5 to 12 in. of snow. Rain and drizzle fell in the Southeast, with totals exceeding 1 in. from Louisiana to Georgia; elsewhere in the Southeast, amounts were generally less than 1 in. (fig. 9D).

In the fourth week, as the high-latitude portion of the North American ridge continued its retrogression into the Arctic Basin, the ridge over the western United States deamplified rapidly, and 700-mb heights became below-normal over all of the country; the lower latitude wave train also retrogressed (figs. 10A and B). The major effect of this on the temperature regime was to lower temperatures in the Northern Plains, for the flow to the east of the upper level High north of Alaska now forced cold air across the Northern Plains and into the East as well (fig. 10C). Mild Pacific air continued to dominate the West, and a combination of Pacific air and circulation from the Gulf of Mexico gave above-normal temperatures to the Southern Plains. The retrogression of the eastern trough this week was associated with two major storms that originated in the Southern Plains and moved through the Northeast, causing most of the heavy precipitation in the eastern half of the country (fig. 10D). Precipitation along the west coast decreased as the upper level flow in that area lost its southerly component, and the anomalous flow became northwesterly (fig. 10B).

Retrogression of the eastern trough continued during the last 3 days of December (circulation and weather not shown), with the result that below-normal temperatures and an upper level trough were observed in the West and warming occurred in the East. A third major storm, which in this instance developed in the Southwest, moved through the South into the East, causing widespread heavy precipitation. A mixture of freezing rain, sleet, and snow fell in the southern Rockies. Snow accumulated a foot or more in the mountains of northern New Mexico and 2 to 6 in. in the Southern Plains. Powerlines and trees were broken by the glazing in central Texas and Oklahoma, and freezing rain iced highways in Ohio, Pennsylvania, southeastern New York, and southeastern New England. Thunderstorms occurred from southeastern Texas to the Middle Atlantic States, and tornadoes struck in Louisiana and Mississippi. The heavy rains in West Virginia, central and eastern Kentucky, and southwestern Virginia melted existing snow cover and caused widespread and serious flooding along smaller rivers. Two persons were drowned, and hundreds of families were homeless in West Virginia.

5. ALASKAN WEATHER

The unusually strong south to southeast flow aloft (figs. 1 and 4) gave Alaska a comparatively mild December. The only below-normal monthly temperature report received was from Shemya, which is well out on the Aleutian Chain. These relatively high temperatures extended to the northern coast of Alaska, where Barter Island and Point Barrow averaged 4.6°F and 3.5°F above normal, respectively. Bettles, with 23.2°F above normal, reported the largest temperature departure during the month. Several stations reported an average of 12°F or more above normal. Along with the anomalous warmth, most of the southern and southeast coastal stations reported more than normal precipitation, but inland stations and stations along the northern and western coasts had generally below-normal precipitation.

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